Measure: Residential Thermal (G2d)

This measure analyzes two different implementation scenarios for increased usage of Solar Hot Water systems in Tucson:

1. Increase access to low-interest financing for capital costs
2. Mandate a solar hot water system on all new residential construction.

* NOTE: The calculations were done contemplating that all new construction water heaters are electric. Gas water heaters emit approximately 2/3 less CO_2e than their electric counterparts.

COT ARRA RFP Summary:

Emission reduction potential by 2020:	82,908 (This would be reduced to ~55,000 if gas v. electric heaters were installed 50/50 in new home construction)
Percentage of goal (2012):	0.43%
Percentage of goal (2020):	3.7% (or 2.4% if gas v. electric heaters were installed 50/50 in new home construction)
Total annual average implementation costs:	$108 (after rebates assuming 20-year life)
Entity that bears the costs of implementation:	Homeowner
Cost/Savings per tCO_2e:	$138 / tCO_2e
Net annual savings:	$162 / home
Entity that realizes the financial return:	Homeowner
Equitability (progressive/regressive, income/revenue neutral, etc):	Only effects participants
Potential unintended consequences:	Possible increased water usage

Background information:

Solar hot water heaters utilize the sun's radiance to augment, or sometimes completely offset, the need for conventional water heating systems, which rely on fossil fuels via electricity and/or natural gas.

Aggressively incentivizing such systems in areas with abundant solar resources (such as Tucson) can lead to quantifiable GHG emission reductions with a net cost savings to the homeowner and payback periods in the range of 5 – 20 years (with The Solar Store estimates ranging from 3-7 years).[1]

Systems for residential use, typically referred to as Solar Domestic Hot Water (SDHW), are comprised of one to two storage tanks and either active or passive solar collectors.[2] For more information on the mechanics of the three primary solar collectors as well as descriptions on active versus passive systems, please see the DOE Energy Savers website under Note (2). As opposed to educating on the mechanics and science, this analysis seeks to quantify the practical implementation of wide-use SDHW systems with Tucson, focusing on systems and energy savings that are most applicable to the region. Fortunately, a unique non-profit, the Solar Rating and Certification Corporation (SRCC), exists that certifies solar energy products and provides regional average annual energy savings.[3]

Under current, local incentive structures, there is a wide range of net installed costs among systems ranging from $4,000 to $7,000 depending on the type of system. Savings to the homeowners can total $270 annually from reduced energy use.

Business as usual:

Absent increased incentives and/or mandating solar hot water systems, this cost- and energy-saving measure could continue to go underutilized in the region. Tucsonan homeowners are currently missing out on over 2,700 kWh of savings per year by not installing such systems.

Description of Measure and Implementation Scenario:

The carbon and economic analysis assumes homeowners install a SDHW system that meets the industry OG-300 standard (also a TEP rebate requirement). Implementation scenarios to increase the amount of SDHW uptake in the City are based on:

1. Increasing homeowners' access to financing repaid via property tax increase over the life of the loan. Uptake is assumed to be 372 homes per year.
2. Following the State of Hawaii's lead in mandating SDHW on all new home construction. New home construction projections are based on 3,500 homes per year with a home occupancy rate of 90%.[4]

Whether or not additional financing is made available to property owners, this measure can be combined with the Residential Community Climate Challenge (Measure E14). As the Climate Challenge is a public education campaign, marketing of the financial and energy savings need to be made clear to potential participants.

Has the Measure been implemented elsewhere and with what results?:

The City of Berkeley implemented a Financing Initiative for Solar and Renewable Technology (FIRST) pilot program that is intended to assist homeowners with the capital costs of installing solar energy systems.[5] FIRST allows a citizen to borrow money from the City, which is then paid back over the life of the loan via increases in their property tax bills, and the City of Berkeley has produced a implementation guide for local governments.[6] Property tax based financing has now gained traction and is commonly referred to as PACE (Property Assessed Clean Energy) financing. According to the Alliance to Save Energy: [7] [8]

> "*PACE financing allows property owners to benefit from energy savings immediately while spreading the cost of improvements over a number of years. The PACE model addresses and overcomes challenges that both borrowers and lenders have identified in seeking to use traditional finance mechanisms to fund efficiency improvements.*"

Berkeley's pilot can be considered a success. They targeted 40 homes an ended with 13 PV systems installed under the FIRST mechanism and more via home equity loans (due to the more favorable interest rates). According to the survey in their assessment, knowledge of and access to financing to overcome the capital costs of utilizing solar PV had significant influence in their participation[4].

Via legislation SB644, Hawaii has mandated that all new single-family homes include a SDHW system.[9] In the Bill's language, the legislature estimates that the mandate could mitigate 10,260 tons of GHG emissions per year based on a projection of 5,700 homes built per year.[10] (NOTE: this projection of 1.8 tons of CO_2e per home per year is similar to the below projected 2.4 tCO_2e savings for Tucson.)

Energy/Emission analysis:

An SDHW system that meets the OG 300 standard can be expected to save 2,750 kWh of electricity per year.[11]

Description	***Input***	***Notes***
Expected annual electricity savings of a OG 3000 SDHW system in Tucson, AZ	2,750	kWh
COT electricity grid emissions factor	856	gCO_2e
Expected annual GHG savings per home per year	2.4	tCO_2e
Incentives		
Homes assumed to utilize increased incentives and install SDHW per year	372	See economic analysis for incentives
Resulting GHG mitigation potential (2020)	8,757	tCO_2e
New Single-Family Home Mandate		
Projected occupied new homes annually	3,150	
Resulting GHG mitigation potential (2020)	74,151	tCO_2e

Contribution analysis:		
COT 1990 Citywide GHG emissions (baseline):[12]	5,461,020	tCO_2e
MCPA 7% reduction target for COT:	5,078,749	
2012 BAU GHG emissions projection:	7,000,000	
2020 BAU GHG emissions projection:	7,343,141	
GHG emissions reduction to meet 7% goal (2012):	1,921,251	
GHG emissions reduction to meet 7% goal (2020):	2,264,392	
Residential Thermal- Increased Uptake via Incentives		
Contribution of G2d Residential Thermal (in 2020):	8,757	tCO_2e
2020 Contribution of G2d Residential Thermal:	0.39%	%
Residential Thermal- New Single-Family Home Mandate		
Contribution of G2d Residential Thermal (in 2020):	74,151	tCO_2e
2020 Contribution of G2d Residential Thermal:	3.27	%

Economic analysis:

Description	***Input***	***Notes***
Annual home electricity use in Tucson	11,000	kWh
Percentage of electricity consumed for water heating	25%	
Annual electricity use for water heating	2,925	kWh
Electricity costs per kWh	$0.08	Assumed to increase per this report's Energy Forecast
Capital cost of SDHW system	$7,000	
TEP Upfront Incentive (UFI)	$750	
TEP Performance Incentives (spread over 2 years)	$1,000	
Expected annual electricity savings	2,750	kWh
Federal rebate (30%)	$2,100	
State rebate (25%, max $1,000)	$1,000	
Cost after rebates	**$2,150**	
Life of analysis	20 years	

Based on the above inputs, the total savings to a homeowner retrofitting their current conventional system with SDHW has a net present value of $3,239 with a payback period of under 10 years. The savings are increased if the homeowner has to replace their current conventional system and is choosing between the two systems.

- ***Savings*** per tCO_2e = ***$137.60 / tCO_2e***

Co-benefits:

Installation of SDHW systems cushion owners from fossil fuel rate spikes and it is reported that energy efficiency upgrades increase home resale values.[13] Moreover, incentivizing accelerated uptake of clean technology can help spur the local economy and small businesses. It also helps in job creation based on the new demand for skilled and knowledgeable plumbers. Lastly, this Measure is synergetic with the Community Climate Challenge (Measure E14), and the two, among others, should be considered in concert.

Equitability:

PACE type loans effect only those who choose to participate in the program, whereas Feed-In-Tariffs (FITs) such as Tucson Electric Power's Renewable Energy Standard Tariff (REST) affects all consumers of the utility. For this reason, this program is more equitable by not charging households in every income bracket a flat rate

Potential unintended consequences:

A potential negative unintended consequence is the increased use of water due to the availability of low cost hot water for domestic use. Another potential negative outcome is that the retrofit may not be permanent. The current homeowner could decide to go with a "conventional" system at the end of the SDHW system's life.

General Note: All references retrieved October through December of 2010 unless otherwise noted.

Endnotes:

[1] http://www.solarstore.com/index.php/faqs/1-solar-faqs/21-incentives-what-is-the-payback-time-for-a-solar-water-heater-
[2] http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12850
[3] Solar Rating and Certification Corporation: http://www.solar-rating.org/
[4] Derived from: http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=16000US0477000&-qr_name=ACS_2009_5YR_G00_DP5YR4&-ds_name=ACS_2009_5YR_G00_&-_lang=en&-_sse=on
[5] Berkeley FIRST Initial Evaluation: http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Berkeley%20FIRST%20Initial%20%20Evaluation%20%20final%20(2).pdf
[6] http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Guide%20to%20Renewable%20Energy%20Financing%20Districts2009.pdf
[7] http://ase.org/sites/default/files/PACE_factsheet.pdf
[8] Currently, many such financing mechanisms are suspended due to a controversy that Federal Housing Finance Agency is unwilling to accept mortgages that have a PACE lien to reduce their liability relative to mortgage defaults.
[9] http://www.cleanenergyauthority.com/solar-energy-news/solar-hot-water-heaters-mandatory-in-hawaii/
[10] http://www.capitol.hawaii.gov/session2008/bills/SB644_cd1_.htm
[11] See TEP Green Energy- Solar Hot Water FAQs: http://www.tep.com/Green/Home/Solar/spaceheating.asp
[12] PAG Regional Greenhouse Gas Inventory- 2010

[13] http://www.nrel.gov/docs/legosti/fy96/17459.pdf